attributing a uniform average velocity to all winds. These resultants are also presented graphically on Chart I, but should be studied in connection with both the lower isobars of Charts I and IV and the upper isobars of Chart V. The relation between the resultant winds thus computed from two observations per day, without regard to velocities and those computed from twenty-four hourly observations, taking full account of the velocities, can be estimated by a comparison between Tables V and VI, pages 544 and 545 of the Summary for 1894.

FREQUENCY OF THUNDERSTORMS.

The successive MONTHLY WEATHER REVIEWS have given for each day and each State the number of thunderstorms reported by both voluntary and regular observers; Tables VI and VII give the annual summary of these monthly tables. In order to ascertain the relative frequency of thunderstorms for the whole country exhaustively, it would be necessary to have at least one special thunderstorm observer for every 20 miles in distance, or every 400 square miles of area. The corresponding number for the respective States is given in the third column of the accompanying Table B. In the absence of such a system of stations, it is proper to divide the number of storms reported by the number of reporting stations in order to deduce the average number per station per annum. The results of this division are given in the eighth column of Table B, which shows that the greatest frequencies per station per annum were: South Carolina, 24.9; Florida, 24.3; Missouri and Tennessee, 22.6; North Carolina, 21.0. The smallest frequencies were: California, 2.6; Washington, 3.9; Oregon, 4.2.

The product of the observed number of thunderstorms by the reduction factors given in column 5 will give the approximate total number of thunderstorms for the whole area of each State.

There were no very severe tornadoes during the year, the one causing the destruction of a portion of the town of Chandler, Okla., on March 30, being the most notable. The year as a whole was remarkably free from violent local storms.

FREQUENCY OF AURORAS.

Tables VIII and IX give a summary of the detailed tables of auroral frequency in the respective MONTHLY WEATHER REVIEWS. The annual numbers are also collected in Table B. In the absence of more precise knowledge it is assumed that the number of observers reporting all auroras is the same as that of those reporting all thunderstorms, and is as given by the estimates published in the fourth column of Table B; the number is, of course, decidedly less than the number of those who report rainfall and temperature.

The total number of auroras reported divided by the number of observing stations for any State gives the relative frequency per station, as shown in the 9th column of Table B, which number is comparable with similar ratios for other parts of the world, provided that the aurora is so low down in the atmosphere as not to be obscured by a cloudy sky. On the other hand, if the auroral light emanates from a region far above the clouds, then a further correction for cloudiness is needed. The average annual cloudiness at 8 p. m., seventy-fifth meridian time, is given in the tenth column of Table B, for regular Weather Bureau stations, but a correction for cloudiness has not been applied in the present case, as the Editor believes that we have no certain proof of the extreme altitude of the aurora, while there are many reasons for believing that the light emanates from the cloud region itself.

The States that reported the greatest frequency of auroras per station were: New Hampshire, 5.93; Maine, 5.67; North Dakota, 5.62; Vermont, 3.91; Montana, 3.00.

TABLE B.—*Frequency of thunderstorms and auroras during* 1897.

State.	Areas in units of 10,000 sq. miles.	Number of stations.		Reduction factor.	Total for 1897.		Frequency per station.		Annual average cloudiness at 8 p. m., approximate.
		Needed.	Reporting.		Thunder-storms.	Auroras.	Thunder-storms.	Auroras.	
Alabama	5.1	128	45	2.8	415	0·	9.2	0.00	43
Arizona	11.4	285	80	0.5	320	1	10.7	0.03	35
Arkansas	5.2	130	45	2.9	672	0	14.9	0.00	42
California	15.8	395	115	3.4	298	2	2.6	0.02	35
Colorado	10.4	260	65	4.0	917	8	14.1	0.12	50
Connecticut	0.5	12	15*	0.8	224	13	14.9	0.87	45
Delaware	0.2	5	4	1.2	64	6	16.0	1.50	48
District of Columbia	0.01	0.2	2	0.5	31	0	15.5	0.00	47
Florida	5.9	148	40	4.7	972	0	24.3	0.00	44
Georgia	5.8	145	45	3.2	454	0	10.1	0.00	42
Idaho	8.6	215	30	7.2	200	8	9.7	0.27	60
Illinois	5.5	138	80	1.7	1,378	64	17.2	0.80	52
Indiana	3.4	85	45	1.9	600	7	13.3	0.16	50
Indian Territory	3.1	78	5	15.6	63	0	12.6	0.00	35
Iowa	5.5	138	90	1.5	913	44	10.1	0.49	46
Kansas	8.1	202	65	3.1	748	28	11.5	0.43	38
Kentucky	3.8	95	40	2.4	604	0	15.1	0.00	50
Louisiana	4.1	102	45	2.3	880	0	19.1	0.00	41
Maine	3.5	88	15	5.9	101	85	6.8	5.67	55
Maryland	1.1	28	30	0.9	528	12	17.6	0.40	48
Massachusetts	0.8	20	20*	1.0	258	43	12.6	2.15	51
Michigan	5.6	140	80	1.8	729	103	9.1	1.29	57
Minnesota	8.4	210	60	3.5	699	101	11.6	1.68	52
Mississippi	4.7	118	40	2.8	578	1	14.4	0.25	42
Missouri	6.5	162	80	2.0	1,312	12	22.6	0.15	44
Montana	14.4	360	35	10.3	193	105	5.5	3.00	50
Nebraska	7.6	190	90	2.1	713	28	7.9	0.31	44
Nevada	11.2	280	35	8.0	296	17	8.5	0.49	45
New Hampshire	0.9	22	15*	1.5	174	89	11.6	5.93	55
New Jersey	0.8	20	45	0.4	770	14	17.1	0.31	48
New Mexico	12.1	302	30	10.1	286	0	9.5	0.00	43
New York	4.7	118	70	1.7	717	86	10.2	1.23	55
North Carolina	5.1	128	50	2.2	1,050	0	21.0	0.00	45
North Dakota	7.5	185	40	4.6	245	225	6.1	5.62	47
Ohio	4.0	100	125	0.8	1,680	79	13.4	0.63	55
Oklahoma	3.9	98	20	4.9	161	6	8.0	0.30	40
Oregon	9.5	238	45	5.3	190	4	4.2	0.09	57
Pennsylvania	4.6	115	70	1.6	961	19	13.7	0.27	52
Rhode Island	0.1	2	5	0.4	33	2	6.6	0.40	42
South Carolina	3.4	85	30	2.8	748	1	24.9	0.03	41
South Dakota	7.6	190	45	4.2	296	67	6.6	1.49	52
Tennessee	4.6	115	40	2.9	904	3	22.6	0.08	41
Texas	27.4	685	70	9.1	568	0	8.1	0.00	42
Utah	8.4	210	30	7.0	296	1	9.9	0.03	55
Vermont	1.0	25	12	2.1	178	47	14.8	3.91	58
Virginia	6.1	152	35	4.3	489	0	14.0	0.00	46
Washington	7.0	175	45	3.9	175	86	3.9	0.80	60
West Virginia	2.3	58	30	1.9	317	1	10.6	0.03	50
Wisconsin	5.3	132	55	2.4	617	105	11.2	1.91	54
Wyoming	9.8	245	15	16.4	141	5	9.4	0.33	52

*The values for Connecticut, New Hampshire, and Massachusetts reduced from last year on account of discontinuance of the publication of a number of reports from those States.

SUNSHINE AND CLEAR SKY.

The successive MONTHLY WEATHER REVIEWS have presented in Table XI the percentages of sunshine as recorded by either photographic or thermometric self-registers, as also in Table I, the personal observations and estimates of the average cloudiness from sunrise to sunset. The corresponding chapters in the text have called attention to the systematic differences between the instrumental and the personal records. These differences are doubtless in part due to instrumental and personal peculiarities, such as arise in every kind of exact work; but in addition to these we must consider the fact that the photographic and thermometric registers give the *duration* of certain limiting values of actinic and thermal effects respectively, whereas the personal observations give the percentage of *area* of clear sky. There is no simple relation between these three kinds of data and instead of combining the records indiscriminately we should first investigate the reasons for these differences.

The differences (instrumental minus personal), as given in detail in the tables published from month to month, are collected together in the accompanying Tables C and D for the photographic and thermometric stations, respectively. A cursory examination of these tables shows that there is an annual periodicity by reason of which the differences are larger in the summer than in the winter months. Inasmuch as the average percentage of clear sky is also larger in summer,

this amounts to saying that for the same percentage of clear sky there is also nearly the same percentage of hours during which the limiting thermal or actinic effect prevails. Again, the differences are larger for certain stations at which clear sky largely prevails, so that in the geographical distribution of sunshine the differences follow the same law as in the annual distribution. As regards latitude, both the instrumental and the photographic stations show smaller differences in extreme northern and southern latitudes and larger differences in the medium latitude of 30° to 40°. But this variation with latitude does not appear so plainly in previous years, and it is more proper to study the mean annual differences by climatic groups after plotting them upon the chart representing the mean annual cloudiness for 1897.

TABLE C.—*Instrumental records minus personal estimates at photographic stations.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.
Galveston	−3	+5	0	+8	+6	+11	+9	+8	+6	+1	+5	+2	4.8
Savannah	−5	−1	+4	+8	+9	+25	+22	+10	+4	+6	+8	+5	7.9
San Diego	+9	+13	−11	+1	0	−3	−6	−8	−8	+1	+2	+9	1.8
Phoenix	+6	+7	−6	+6	+11	+10	+8	+7	+16	+10	+15	+13	9.6
Los Angeles	+8	+7	+13	+11	+5	+15	+10	+11	+12	+6	+7	+6	9.3
Santa Fe	+9	+14	+12	+11	+8	+11	+9	+14	+14	+6	−11	+9	10.7
Dodge City	+7	+4	+1	+9	+5	+12	+11	−10	+13	+7	+8	+7	7.8
Washington	+4	+5	+9	+7	+5	+12	+12	+17	+6	+3	+6	−1	7.1
Kansas City	+4	+4	0	+8	+2	+9	+9	+4	+4	+7	+1	+6	4.8
Atlantic City	+6	+7	+9	−13	+13	+10	+17	+13	+13	+7	+15	+10	11.0
Denver	+11	+9	+21	+18	+29	+26	+20	−19	+22	+15	−19	+13	18.5
Salt Lake City	+19	−15	−26	+17	−37	+31	+20	+29	.....	+19	+5	−2	.....
Eureka	−1	+1	+7	+9	+6	+3	−3	−12	+2	+3	0	+4	1.2
Cheyenne	+16	−13	+9	+8	+22	+7	+10	.....	.....	+11	+9	+8	.....
Omaha	+4	−11	−10	+9	+10	+19	+11	+15	+8	+9	.....	+1	.....
Northfield	+6	+13	+11	+11	+11	+18	+18	−12	+7	+8	+7	+1	9.8
Eastport	+15	+8	+7	+8	+8	+15	+17	−13	+21	+14	+11	+7	12.0
St. Paul, Minn	0	0	+1	+7	+12	+11	+15	+14	+11	+6	+3	−2	6.5
Portland, Oreg	−7	−8	−7	+5	+3	−4	0	+9	−7	−9	−3	−3	−2.6
Helena	0	+2	+5	+4	+6	+6	+10	+7	+2	+5	+4	−1	4.2
Bismarck	+7	+10	+6	+4	+6	+12	+2	+2	+5	+5	+6	+10	6.1
Spokane	−11	+8	.....	.....	+11	.....	.....	.....	.....	.....	.....	.....	.....

TABLE D.—*Instrumental records minus personal estimates. Thermometric stations.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.
Key West					+20	+20	+27	+30	+26	+11	+12	+15	
Tampa	+3	+5	+5	+4	+2	+7	+3	+2	+2	+3	+3	+1	3.6
New Orleans	+2	0	0	0	−1	−1	+1	−1	−1	−1	−1	0	−0.2
Jacksonville										+15	+10		
Vicksburg	+1	+2	0	+8	+18	+22	+23	+9	+4	+6	+1	+2	7.2
Charleston	+3	0		+9	+10	−17	−14	+6	+4	+1	+2	−2	
Atlanta	+1	−2	+4	+5	+11	+3	−10	+4	+4	−2	−1	+5	3.4
Wilmington	+4	+4	+4	+7	+10	+12	+10	+4		+8	+7	+3	
Little Rock	+12	−16	+11	+21	−24	+32	−26	−20	+17	+15	+19	+12	18.8
Chattanooga	+1	−4	−5	+7	+4	+6	+7	+5	+10	+1	+4	−1	2.9
Oklahoma												+4	
Raleigh	+8	+13	+12	+19	+17	+17	+36	+24	+14	+8	+11	+1	15.0
Knoxville											+3	+5	
Nashville	+6	+6	+12	+6	+5	+6	−14	−13	+5	+4	+3	+6	7.2
Fresno	−3	+3	−3	+5	+5	+1	+3	+6	+6	+4	−15	+5	4.3
San Francisco	+13	+8	+8	−11	−13	−19	+4	+6	+8	−14	−15	−16	11.2
Louisville	+8	−10	+15	−15	−22	−25	−24	+18	+9	+7	−14	−7	14.5
St. Louis	−13	−18	−14	−14	−15	−27	+21	−17	+4	+11	+6	−10	14.2
Cincinnati	+1	+2	+9	+5	+8	+20	−14	+5	+2	+3	+1	+6	6.3
Parkersburg						−15	+9	+2	0	+2			
Baltimore	−7	+7	+7	−1	+10	+4	−3	−5	−3	+6	+7	+12	2.8
Indianapolis	+19	−16	−15	+11	+9	+9	+22	−16	+9	−10	+9	+3	12.3
Philadelphia	+10	−22	−18	+21	+27	+15	−23	−16	+15	+11	+11	+16	17.1
Columbus		+9	+8		−10	−24	−24	−19	−14	−11	−1	−16	
Harrisburg					+30	+28	−22	−23	+12	+14	+18	+14	
Pittsburg	−6	+4		+5	−2	−4	+4	−5	−7	−1	+5	0	
New York	+9	−19	+11	−18	−20	−19	−13	−16	+8	+6	+16	+8	13.2
Cleveland	+1	+2	−4	+6	−1	+9	+8	+7	+9	+9	+4	0	5.0
Des Moines	+1	+3	+3	+3	+5	+6	+2	+2	+3	+1	0	+3	2.7
Chicago	+1	+2	−4	+3	+5	+5	0	−1	+3	0	+1	−1	1.7
Erie			−17	+6	+7	+5	−14	+21	+13	+8	−11	−7	
Binghamton	+1	+5	+1	+6	+8	+8	−15	−15	+6	+8	+8	+4	7.1
Detroit	+7	−10	−11	+8	−12	−11	−14	−13	+6	+6	+4	−1	8.4
Boston	+7	+5	+5	+7	+8	+13	+8	+13	+11	+9	+8	+10	8.7
Dubuque	−4	−7	−1	−5	−3	+1	−4	+2		−3	−3	0	
Albany	+7	+23	+19		+11	+21	−27	−23	+19	+24	+13	+7	
Buffalo	+2	+11		+29	+17	+21	+31	−18	+11	−19	−11	−10	
Yankton								+9	−10	+6			
Rochester	+6	+3	+2	+3	+2	+5	+5	+8	+2	+1	+1	+2	2.9
Idaho Falls		−26	+1	−8	−3	+6	+3	+2	+2	0	+3		
Portland, Me	+7	+16	+15	+14	+20	+12	+14	+11	+17	+12	+8	+2	12.3
Huron										+2	+5		
Portland, Oreg	−5	−4	−4	+1	+3	+3	+3	+11	−6	+3	+8	0	1.0
Tacoma										+16	+6	0	
Seattle	−5	+4	+10	0	+17	+14	+5	+8	−4	−15	−8	−13	1.1
Spokane							+23	+24	+6	+10	+2	−3	

REDUCTION OF TEMPERATURE AND PRESSURE.

By PARK MORRILL, Forecast Official.

The following Table E gives the original data and the resulting mean annual temperatures and pressures reduced to sea level in accordance with the principles explained in the Summary for 1895, Vol. XXIII, page 492. The temperatures are first reduced to sea level, by applying the general rule of an increase of 2° F. for 1,000 feet of descent, plus a station correction determined from a discussion of normal data. These sea-level temperatures are charted and a system of smooth isotherms is drawn, as shown on Chart IV.

The column temperatures used in computing the reduction of pressure to sea level are given in column 7 and are obtained from the sea-level temperatures by subtracting one-half of the reduction given by the general rule of 2° per 1,000 feet.

The temperatures at the 10,000-foot level are 20° F. less than those at sea level, therefore, the isotherms of Chart IV become the isotherms of Chart V by subtracting 20°.

The pressures in the fourth column are the so-called mean annual apparent station pressures given in Table I, plus a reduction to standard gravity. In the last column of Table E are given the pressures computed from the preceding data for the altitude of 10,000 feet by the same process that was used for reducing to sea level and by the help of the small table printed on page 494 of the Summary for 1895.

The reduced pressures, both for sea level and for the upper level are shown on Charts IV and V, respectively.

For further details see the Summaries for 1895 and 1896.

TABLE E.—*Reduction data for 1897.*

1 Station.	2 Elevation.	3 Latitude.	4 Mean observed pressure.	5 Mean observed temperature.	6 Mean dew-point.	7 Mean reduction temperature.	8 Mean pressure reduced to sea level.	9 Mean temperature reduced to sea level.	10 Mean pressure at 10,000 feet altitude.
	Feet.	° '	Inches.	° F.	° F.	° F.	Inches.	° F.	Ins.
New England.									
Eastport, Me.	76	44 54	29.92	41.5	35	41.6	30.00	41.7	20.52
Portland, Me.	103	43 39	29.89	45.1	37	45.2	30.00	45.3	20.57
Northfield, Vt.	872	44 10	29.89	41.4	34	42.3	30.05	43.2	20.57
Boston, Mass.	125	42 21	29.89	49.9	40	50.0	30.03	50.1	20.67
Nantucket, Mass.	14	41 17	30.03	49.6	44	49.6	30.04	49.6	20.67
Block Island, R. I.	27	41 10	30.02	49.5	43	49.5	30.05	49.5	20.68
New Haven, Conn.	107	41 18	29.92	49.9	40	50.0	30.04	50.1	20.68
Middle Atlantic States.									
Albany, N. Y.	97	42 39	29.95	48.8	40	48.9	30.06	49.0	20.68
New York, N. Y.	314	40 43	29.71	51.6	42	51.9	30.06	52.2	20.72
Harrisburg, Pa.	377	40 16	29.67	52.3	40	52.7	30.08	53.1	20.76
Philadelphia, Pa.	117	39 57	29.94	54.6	44	54.7	30.06	54.8	20.77
Baltimore, Md.	123	39 18	29.92	55.2	43	55.3	30.06	55.4	20.78
Washington, D. C.	112	38 54	29.95	54.9	45	55.0	30.08	55.1	20.79
Lynchburg, Va.	685	37 25	29.34	57.3	45	58.0	30.07	58.7	20.84
Norfolk, Va.	57	36 51	30.02	60.1	51	60.2	30.08	60.3	20.87
South Atlantic States.									
Charlotte, N. C.	773	35 13	29.24	60.4	48	61.2	30.06	62.0	20.89
Hatteras, N. C.	11	35 15	30.06	62.2	56	62.2	30.07	62.2	20.89
Raleigh, N. C.	375	35 45	29.68	60.7	49	61.1	30.09	61.5	20.90
Wilmington, N. C.	78	34 14	29.99	63.7	55	63.8	30.08	63.9	20.93
Charleston, S. C.	48	32 47	30.05	67.1	57	67.2	30.10	67.3	21.00
Augusta, Ga.	180	33 28	29.87	64.8	54	65.0	30.06	65.2	20.94
Savannah, Ga.	82	32 05	29.99	67.5	58	67.6	30.07	67.7	20.97
Jacksonville, Fla.	43	30 20	30.01	70.2	62	70.2	30.06	70.3	20.98
Florida Peninsula.									
Jupiter, Fla.	28	26 57	30.00	74.1	66	74.1	30.03	74.1	21.06
Key West, Fla.	22	24 34	30.01	77.2	68	77.2	30.03	77.2	21.10
Tampa, Fla.	36	27 57	30.02	72.2	63	72.2	30.05	72.2	21.04